META-ANALYSIS OF STATED PREFERENCE ENVIRONMENTAL VALUATION STUDIES IN CHINA, WITH IMPLICATIONS FOR BENEFIT TRANSFER

by

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Meta-Analysis of Stated Preference Environmental

Valuation Studies in China, with Implications for Benefit Transfer

Zhan Wang

Abstract

As an approach for nonmarket valuation, benefit transfer uses the results of existing studies to predict the values of goods and services at sites where original valuation studies have not been conducted. It has the advantage of saving time and funding, but it depends heavily on the characteristics of the original studies as well as the transfer method. Considering the increasing demand for environmental valuation in China, benefit transfer may play an important role in assisting natural resource and environment management. This Master's project created a database of stated preference studies on environmental valuation in China (Mainland China, Hong Kong, Macau and Taiwan), and it applied a meta-analytic benefit transfer approach to the database to study factors that influence willingness to pay and the accuracy of alternative benefit transfer methods.

The results indicated that the number of stated preference valuation studies in China has increased in recent decades, but the studies are distributed unevenly across the country and focus on different environmental assets in different regions and time periods. The meta-analysis found that several variables, including response format, research format, payment interval, payment vehicle, document type, and specific environmental assets such as air quality, have a significant influence on willingness to pay estimates. A trimmed version of the full model had the best performance in terms of transfer accuracy, followed by a stepwise trimmed model, a central tendency approach, and the full model. These findings suggest that the meta-analytic benefit transfer method can serve as a useful tool for Chinese environmental management.

Keywords: Meta-analysis, Benefit transfer, China, Environmental valuation

1. Introduction

Ecosystem services refers to the goods and services that benefit human beings through directly or indirectly approaches, including the life supporting services such as material circulation and waste treatment, the resource producing services such as raw materials and energy, and also the passive use services such as recreational, cultural and aesthetic services (Costanza, 1997). Despite their importance, currently not all of the ecosystem services can be valued in monetary terms via market, which causes the underestimation or neglect of ecosystem services in social development and the degradation of environment. Thus a series of non-market evaluation methods were developed, including revealed preference approaches such as travel-cost method and hedonic method, and stated preference approaches including contingent valuation method and choice experiment (Riera et al, 2012). Among them, the stated preference approach shows the flexibility to environmental goods evaluated as well as the feasibility on researching passive values, thus has been widely applied in environmental and resource economics over 40 countries (Carson et al, 2001).

However, the original stated preference approach may not always be the best choice or even possible because of time, funding and data availability restraints (Johnson and Rosenberger, 2009). Thus the method of benefit transfer was developed to evaluate environmental resource and services, with the assumption that sites with similar attributes or characteristics would have similar valuation results. Benefit transfer estimates the use and non-use value in policy site based on the outcomes of previous studies rather than conducting original studies, which can be used when the funding, time and other resources are not sufficient to conduct an original study (Champ et al, 2003, Rosenberger and Loomis, 2000). Benefit transfer can be conducted via point value estimate transfer, benefit function transfer, and meta-analytic transfer. The meta-analytic transfer approach uses summary statistics from multiple studies to research the influence of methodology and study specific factors on evaluation outcome (Champ et al, 2003), and its applications include species and natural conservation (Lindhjem and Tuan, 2012), forest conservation (Lindhjem, 2007), recreation (Shrestha and Loomis, 2001), coastal zone management (Zhai and Suzuki, 2009) and so on.

As a developing country which is experiencing rapid development as well as intense environmental challenges such as air and water pollution and nature degradation, China has

increasing demands of ecosystem services and environmental quality valuation to assist management and policy making. However, the supply of original studies might not satisfy the demands because of limited researchers, time and funding, thus the benefit transfer method would be an important tool to analyze the value of environmental goods and assist government decisions. Although the existing environmental valuation studies in China (including the mainland China, Hong Kong, Macao and Taiwan) published in English would be limited, the domestic articles published in Chinese would contribute to form a larger sample for more comprehensive meta-analytic benefit transfer. However, with limited previous work, the feasibility of benefit transfer method in China as well as the potential bias and heteroskedasticity problem from combined studies sources are still questioned. This thesis aims to test the influential factors and reliability of meta-analysis benefit transfer of ecosystem services and environmental quality in China, based on studies of stated preference published both in English and in Chinese (Simplified and Traditional).

The objective of research includes three parts. Firstly, a database of stated preference environmental valuation studies in China was established for analysis, which would also benefit further studies in the environmental asset evaluation field for review and reference. Secondly, it would analyze the effect of explanatory variables on the willingness to pay (WTP) of Chinese environmental valuation cases including the effect of methodology, study, ecosystem specific variables such as economic situations, stated preference method, payment characteristics. Thirdly, it would test the accuracy of benefit transfer through meta-analysis methods and central tendency method and analyze the feasibility to conduct benefit transfer analysis in China and provide suggestions on its application. Besides, this thesis would also research the effect of publication language to discover whether there is significant difference between studies published for domestic and international readers. The paper is organized as follows: section 2 illustrates the concept framework of meta-analytic benefit transfer such as the theory, method and application. Section 3 reports the data source and collection process, the descriptive summary of stated preference studies in China and the process of coding studies for meta-analysis. The meta-analysis models are shown in section 4, while section 5 reports the model result and discusses the influential factors and transfer feasibility and section 6 provides the overall conclusion of this research.

2. Concept framework

2.1 Review of benefit transfer method

As is mentioned in section 1, Benefit transfer is described as the approach using results form study sites (sites with information) to estimate the result in policy sites (sites without information) (Champ et al, 2003, Rosenberger and Loomis, 2000), which has been widely used in cost-benefit analysis, environmental accounting or impact assessment (Riera et al, 2012). There are at least three main categories of benefit transfer: point value estimate transfer, benefit function transfer and meta-analysis transfer (Champ et al, 2003). A point value estimate transfer can be as simple as adopting another value observation from an existing study as the transferred value to the policy site, or using the average value of several selected study sites. However, the effect of point estimate transfer was often questioned because the inherent difference between the study sites and policy sites, while the study site similar with policy site may not always be available. Thus the application of point estimate transfer would be limited (Riera et al, 2012).

Benefit function transfer also uses the result from one study, but instead of adopting the value estimation, this method adopts the function of value evaluated (for example WTP) on the independent variables including environmental goods and socio-economics characteristic of respondents, and replaces the independent variables with those from policy site to produce transfer outcome (Riera et al, 2012). That is to say, the point estimate transfer assumes the policy site has the similar characteristics with study site, while benefit function transfer releases the assumption and assume that the impact of site characteristics (the coefficients in benefit function) are similar between policy site and study site. Although more information is used in benefit function transfer, existing studies indicate that it may not have significant effect on transfer error reduction (Riera et al, 2012).

If value evaluated and independent variables are collected from multiple studies and combined to produce a common benefit function, the approach is defined as the meta-analytic benefit transfer (Riera et al, 2012), which releases the assumption again to reproduce the coefficients based on the sample of original studies. Because of its advantage on data flexibility and information usage, meta-analytic evaluation has been applied broadly in environmental economics field. Although some studies using meta-analysis did not come in the form of benefit analysis, they followed the similar theorem. The existing application includes studies on biodiversity and nature

conservation (Lindhjem and Tuan, 2011; Jacobsen and Hanley, 2008), forest (Lindhjem and Navrud, 2008; Barrio and Loureiro, 2010), mangrove (Salem and Mercer, 2012), urban open space (Brander and Koetse, 2011), wetland (Ghermandi et al, 2010), outdoor recreation (Shrestha and Loomis, 2001) and so on. Although the meta-analytic benefit transfer approach was assumed to be useful and more accurate than point transfer or benefit function transfer when applied properly (Champ et al, 2003; Bergstrom and Taylor, 2006; Johnston and Rosenberger, 2009). An important challenge to meta-analytic benefit transfer is the dependence on databases. Since not all original studies would report the value of independent variables, and the selection of those variables would vary significantly across studies because of the difference in methodology, concerned environmental goods and study qualities, to establish the database for analysis could be more difficult than expected (Riera et al, 2012).

Based on the consideration of the methodologies and features of three main approaches of benefit transfer, the meta-analytic approach was paid special attention to evaluate the ecosystem services in China in this thesis. The reasons are as follows. Firstly, even if the number of original studies in China shows an increasing trend (see section 3.3.1, time distribution of meta-data), it is still a relatively small sample comparing to those in developed world, according to the collection of Environmental Valuation Reference Inventory (EVRI), a comprehensive database of environmental goods evaluation studies. What's more, the spatial distribution of existing studies is far from balanced over provinces in China (see section 3.3.2, the spatial distribution of meta-data). Thus the ecosystem services in several regions may fail to find proper study sites for a point estimate transfer. Secondly, as a developing country, the regions over China have significantly unbalanced development, thus the assumption of benefit function transfer that different sites have similar coefficients would be questionable, while meta-analytic benefit transfer would deal with the variance better. Thirdly, considering the increasing demand of environmental goods and services evaluation, the meta-analytic benefit transfer has the potential to be applied as a more general tool in cost-benefit analysis, planning assistance or impact assessment, thus the thesis is expected to have external benefit on real world problems. However, Lindhjem and Navrud (2008) suggested that meta-analytic approach may not always perform better than simper transfer methods such as central tendency approach, and further tests and evidences would be required. Thus the comparison of meta-analytic benefit transfer and central tendency approach was also conducted in the thesis to test this issue with Chinese studies sample.

2.2 Process of conducting meta-analytic benefit transfer

The major process of conducting meta-analytic benefit transfer can be divided into three steps: original studies collection, database establishment and empirical analysis. As an inherent characteristic, the accuracy of meta-analytic benefit transfer depends highly on the input of original studies. Firstly, the searching and selection criteria should be established to control the quality of original studies and also keep consistency when searching across existing databases (Bergstrom and Taylor, 2006). The criteria is usually determined by the objective of benefit transfer, such as the estimated value in policy site, the specific methodology or population concerned, or the particular spatial scope. Searching studies would be conducted through general research database, existing databases of evaluation studies or bibliographies, or source of "grey literature" that did not be peer reviewed and published such as thesis and reports, which may have quality concerns but would help to reduce the publication bias in studies selection (Bergstrom and Taylor, 2006).

After associated original studies are ready, a database should be established to code studies into value observations with dependent and independent variables for analysis, through the data coding and cleaning up process. Although variances exist, researchers of previous studies reached agreement on the following categories (Lindhjem and Navrud, 2008; Shrestha and Loomis, 2001; Jacobsen and Hanley, 2008; Lindhjem and Tuan, 2011):

(1) Dependent variable. The WTP for environmental goods and services are the most commonly reported in evaluation, while studies focusing recreation value would adopt consumers' surplus instead (Shrestha and Loomis, 2001).

(2) Methodological variables, which include the response format, payment interval, payment vehicle, the reference frame and survey method used in the original study.

(3) Environmental asset variables, which include the more precise categories of the goods and services evaluated, or the dummies indicating whether the study is related with a specific topic, such as species, habitats, protect areas and so on.

(4) Geographic variables, which include the region of environmental goods, especially in international studies because the difference in nations may have significant impact on evaluation results.

(5) Socio-economic variables, usually the respondents' income or the GDP per capita are used, which should impact the valuation of ecosystem services and environmental quality according to the utility function.

(6) Study specified variables, such as the survey or publication time of the study, its document category, the sample size and response rate or valid rate. Variables in these categories could be used as study quality control (Riera et al, 2012).

Finally, with the prepared database, regression models can be developed to produce the common benefit function from meta-data for benefit transfer result. The methodology and model development process would be discussed further in section 4.

3. Collection of Data

3.1 Studies collection

In order to conduct meta-analysis for the ecosystem services and environmental quality in China, a database is needed to capture available and useable studies and record the information. Several databases of environmental goods evaluation have been established, including the EVRI, the Environmental Valuation Database (ENVALUE), Valuation Study Database for Environmental Change in Sweden (ValueBaseSWE), the New Zealand Non-market evaluation Database and so on. However, those existing databases either only contains domestical studies such as ENVALUE, ValueBaseSWE and the New Zealand Non-market evaluation Database, or has limited records of Chinese studies. Besides, none of the existing databases contains non-market evaluation studies published in Simplified or Traditional Chinese, which would make up a larger sample and add diversity in the meta-analysis.

Thus a database of Chinese environmental assets evaluation studies was established. The studies collection process was finished in May, 2013. According to the research objective, the database sets the selecting protocol as using stated preference methods on environmental quality and ecosystem services. Studies including includes journal articles, Master and Doctoral thesis, research report and conference paper and published in English, Simplified Chinese and Traditional Chinese were searched from Web of science, EVRI, China National Knowledge Infrastructure (CNKI)'s database (a main reference source in Mainland China) and Airiti library (a reference source in Taiwan). The material collection was conducted through three stages. The first stage was to search articles with the keywords of "Contingent Valuation", "Choice Experiment", "Choice Model" and "Conjoint Analysis" (as well as "China/Chinese" in English source) in title, abstract and keywords from the databases mentioned above. The second stage was to conduct manual selection of stated preference studies focusing on the evaluation of environmental assets in China. Studies not using the primary stated preference method or not evaluating environmental assets were excluded during this stage. In the third stage, the valuation outcome and the methodology, study and ecosystem specific variables are coded from studies to form the meta-analysis database. If the study failed to report the evaluation result, evaluated the asset unrelated with ecosystem services and environmental quality or only reported Willingness to accept, or was published in other articles, it is not coded but also recorded for future use. Thus

the main products of this Master Project include a database of stated preference studies on environmental assets in China with detailed information for analysis, and a general database of stated preference studies on environmental topics for reference. The analysis shown below is all based on the database for analysis.

3.2 Coding process

After the studies were collected, a series of dependent and explanatory variables should be selected to code the studies for meta-analysis. The variables should be comprehensive enough to adapt to the content of articles and guarantee the freedom for analysis and further researches. Based on the literature review of previous meta-analysis studies (Shrestha and Loomis, 2001; Lindhjem, 2007; Lindhjem and Navrud, 2008; Jacobsen and Hanley, 2009; Barrio and Loureiro, 2010; Brander and Koetse, 2011; Lindhjem and Tuan, 2012) and valuation research databases (EVRI[1], Recreation Use Values Database[2], Environmental Values of European Forests[3], ENVALUE[4], New Zealand Non-market Valuation Database[5], ValueBaseSWE [6], Beneficial Use Values database[7]), six categories of variables are selected as preliminary choices for database establishment: Dependent variables, Methodological Variables, Environmental assets variables, Socio-economic variables, Geographic variables and Study specific variables. The description of variables coded in the database is shown in table 1.

Table 1: Summaries of variables in database

Column	Value type	Explanation
Observation ID	Text	The ID of separate value observations.
Study ID	Numerical	The ID of separate studies.
Title	Text	The title of listed study
Author	Text	The authors of study in English.
Chinese Title	Text	The title of study in Chinese when available.
Chinese Authors	Text	The authors of study in Chinese when available.
Document category	Dummy	The kind of studies, including journal article, research report, Master or Doctoral thesis.

[1] http://www.evri.ca
[2] http://recvaluation.forestry.oregonstate.edu/database
[3] http://www.bfafh.de/DB_forestvalues.htm
[4] http://www.environment.nsw.gov.au/envalue
[5] http://www2.lincoln.ac.nz/nonmarketvaluation/
[6] http://www.beijer.kva.se/valuebase.htm
[7] http://buvd.ucdavis.edu/

Publication year	Numerical	The reported publication time of the study.
Language[8]	Dummy	The language that the study is published.
Original WTP	Numerical	By default, the average WTPs are taken into analysis because they can be used to calculate the total WTP for policy reference and are reported by more studies.
Original WTP unit	Text	The original unit reported from the study.
WTP (CPI,PPP adjusted to 2010 dollars)	Numerical	The average WTP adjusted to 2010 dollars.
Adjusted WTP unit (2010 USD)	Text	The adjusted unit of WTP in 2010 dollars and per year, if possible.
WTP sample	Dummy	0: If the WTP is the average of all valid samples. 1: If the WTP is the average of sample with only positive WTP. 2: not specified
WTP mean/median	Dummy	0: If the WTP listed is mean value. 1: If the WTP listed is the median value, when the mean WTP wasn't reported.
Household/Individual	Dummy	Whether the WTP is reported per household or per individual.
Valuation method	Dummy	The general valuation method adopted by the study.
Response format	Dummy	The response format of contingent valuation survey.
Payment vehicle	Dummy	The payment vehicle used in the study. If the respondents can choose from multiple payment vehicles, it is coded as "Chosen by respondents".
Payment interval	Dummy	The frequency of WTP payment.
Payment continuance	Dummy	Whether the WTP lasts for limitet time or it is permanent payment.
Research format	Dummy	How the survey was conducted. "Questionnaire" means the survey materials were distributed to respondents via approaches other than mail, email or telephone. without the interaction with interviewers.
Training of interviewers mentioned	Dummy	Whether the study reported the training of interviewers. Since no study mentioned "the interviewers were not trained", the dummy is coded either as "Yes" or "Not specified".
Pre-testing	Dummy	Whether the study reported the implement of pre-test.
Environmental change frame	Dummy	The statement "Conservation/Maintain current situation" cannot be regarded as "For a gain" or "Avoid a loss" clearly, thus it is reclassified as a new category."Payment for ecosystem services" means to ask the payment for value/services.
Studied population	Dummy	The basic situation of studied population.
Information remind	Dummy	Whether the respondents were reminded of budget,

[8] Note: A few of studies published in English are still from Chinese domestic journals. Since the one in English is the only version available, they are regarded as aiming at international audience as other studies published outside of China.

		scope, quantity and quality of goods/services and so on. "Other information" means the description does not mention reminding of scope, budget, actual payment or virtual payment, thus are not paid attention by this study.
Scope test	Dummy	Whether the study reported the consideration or implement of scope test.
“cheap talk” script	Dummy	Whether the study reported the consideration or implement of "cheap talk" script.
General environmental asset	Dummy	The evaluated environmental goods of the study.
Description of evaluated asset	Text	Short note of evaluated environmental goods.
Specific species	Dummy	Whether the evaluated environmental asset is a specific species.
Recreation value	Dummy	Whether the respondents considered the recreation value of the environmental asset during evaluation
Protected area/Natural park	Dummy	Whether the evaluated environmental asset is a protected area or a natural park.
Original mean income (reported and calculated, 110%)	Numerical	The original average income either reported or calculated from subcategories. During the calculation, if the boundaries of subcategories are not specified, 0 is selected as the lower bound and 110% of the available highest income boundary is selected as the upper bound.
Origional mean income (reported and calculated, 125%)	Numerical	The original average income either reported or calculated from subcategories. During the calculation, if the boundaries of subcategories are not specified, 0 is selected as the lower bound and 125% of the available highest income boundary is selected as the upper bound.
Original income unit	Text	The original unit reported from the study.
Mean income (reported and calculated, 110%) (CPI,PPP adjusted to 2010 dollars)	Numerical	The adjusted average income in 2010 dollars annually. During the calculation, with 110% of the available highest income boundary selected as the upper bound.
Mean income (reported and calculated, 125%) (CPI,PPP adjusted to 2010 dollars)	Numerical	The adjusted average income in 2010 dollars annually. During the calculation, if the boundaries of subcategories are not specified, with 125% of the available highest income boundary selected as the upper bound.
Adjusted income unit (2010 USD)	Text	The unit of adjust average income, in 2010 USD per year.
Income calculation	Dummy	0: if the average income is reported. 1: if the average income is calculated from subcategories.
Household/Individual	Dummy	Whether the income is reported per household or per individual.
Schooling year (calculated and provided)	Numerical	If the survey provides average schooling year of the sample, it is listed. Otherwise, it is calculated from the subcategories.

Average schooling year calculation	Dummy	0: average schooling year is reported. 1: average schooling year is calculated from subcategories
Percentage of higher education (Professional college, Undergraduate, Graduate)	Numerical	The percent of respondents graduate from higher education (Professional college, Undergraduate, Graduate)
Mean age	Numerical	If the survey provides average age of the sample, it is listed. Otherwise, it is calculated from the age categories.
Average age calculation	Dummy	0: the mean age is provided. 1: the mean age is calculated from subcategories
Gender	Numerical	The percent of male respondents.
Mainland China, Hong Kong, Macau or Taiwan (environmental goods region)	Dummy	The main region of evaluated environmental asset.
Regions (environmental goods region)	Dummy	The geographic region of evaluated environmental asset.
Province, municipality and autonomous region (environmental goods region)	Text	The province, municipality or autonomous region of evaluated environmental asset, if available.
Mainland, Hong Kong, Macau or Taiwan (Sample region)	Dummy	The main region of sample.
Regions (Sample region)	Dummy	The geographic region of sample.
Province, municipality and autonomous region (Sample region)	Text	The province, municipality or autonomous region of sample, if available.
The location of survey	Dummy	Whether the survey was conducted in urban area or rural area (including suburban area).
Local asset and sample	Dummy	Whether the repondent are evaluating asset from same city or not.
Same-province sample	Dummy	1:the environmental asset and sample are from the same province.
Sample size	Numerical	The sample size may be the respondents interviewed, the telephone number called or the total amount of questionnaire distributed.
Household/Intercept survey(on site)/(on public area)	Dummy	Whether the respondents answered the survey at home (including mail survey, questionnaire, telephone and internet survey are regarded), at the environmental asset evaluated or on public area.
Random sample or convenience sample	Dummy	Whether the study adopts the random sampling method

		or convenience sampling method.
National sample or a subnational sample	Dummy	Whether the sample was from all over China or from subnational regions (for example a province)
Valid rate (calculated)	Numerical	The percent of valid responses from total sample size.
Valid response	Numerical	The number of valid responses.
Survey time (with 2 years delay)	Numerical	The survey time either reported by original study or calculated by applying a 2 year delay from publication time. 2 year is selected because it is is the median, close to the mean (2.44 years), and ranks secondly in frequency. If the survey was conducted cover multiple years, the beginning year is chosen as the survey year.
Survey time calculation	Dummy	0: the survey time is provided. 1: the survey time is calculated by minus 2 years from the publication year.

Source: collection of author

Since all of the values were coded from multiple studies, many of them need to be cleaned up to either fulfill the missing information or to be unified to the single style or currency, which is especially important for the variables from environmental asset, socio-economics and study specific categories. The cleaning up progress was introduced as follows.

3.2.1 Cleaning-up of environmental assets

The environmental asset refers to the environmental goods and services evaluated in the study, which serve as the vehicle as ecosystem goods. Based on the inherent characteristics of environmental assets, they were divided into ten sub categories: air quality, animal/plant/biodiversity, bay/marine, ecosystem/environment in general, forest, grassland, lake/reservoir, river, urban green space and wetland. Here if the study let respondents to evaluate "the improvement or the conservation of ecosystem/environmental quality" without pointing out any specific environmental asset, it is classified into the "ecosystem/environment in general" category. In section 3.3.3, this category is found to vary according to time and geography. Also, since the service of recreation may play a special role in respondents' evaluation and impact the WTP estimates, in this thesis the studies evaluating the recreation value but not related with the quality of environmental assets were excluded, while those evaluating the recreation value that associated with environmental asset were included, but coded with a dummy "Recreation value".

3.2.2 Cleaning-up of study specific categories

Among the study specific categories, one important variable need cleaning up is the study year. The study year refer to the year that the authors conducted the survey, which is associated with

the general situation of the respondent sample and have impact on indexes to adjust other variables, such as the life expectancy used to adjust average age, and the Consumer Price Indexes (CPI) and Purchasing Power Parity (PPP) to adjust the currency value of WTP and income. Some of the studies reported the study year in detail and are coded as provided, while others suggested nothing on the survey time, thus the study year need to be estimated. The estimate rule used here is listed as follows. If the original study provide a time span over 1 year (all the studies' survey span are less than 2 years), the starting year is selected as survey year. If the original study totally lacks the study year information, it is calculated from the available delays between the publication year and the study year from other studies. Since the mean delay equals to 2.41, median is 2 and mode is 1 (while 2 years ranks secondly and close to 1), the 2 year delay was adopted in the database and this thesis. The studies with survey calculated with delays are noted out with dummy "survey year calculation".

3.2.3 Cleaning-up of socio-economic variables

Among the studies collected with full socio-economics variables available, only a few of them provide the mean of variables such as income, age and education level (represented by diploma received or schooling year), instead, the majority of studies provided the distribution of value categories. Thus the mean value should be calculated for further analysis. Dummy variables are created to distinguish the socio-economic value reported in article or calculated from distribution.

The educational levels and corresponding schooling years are divided as Illiterate (0 years), Elementary school (6 years), Junior high school (9 years), Secondary vocational school/ Senior high school (12 years), Professional college/Undergraduate (16 years), Master degree (19 years) and PhD degree (21 years). . The mean value of a category's upper and lower bound is regarded as the category's value. If the category is defined as above or below certain degree without mentioning the upper or lower bound, then the upper bound is set as 21 years (graduate from PhD degree) and the lower bound is set as 0 years (illiterate). Also, the percentage of higher education (Professional college, Undergraduate, Graduate) is calculated as an alternative education level variable to prevent the bias of boundary setting.

The mean of respondent's age is calculated based on the distribution provided in original study. Similarly, if the category does not provided the upper or lower bound, 16 is chosen as the lower bound because some studies provided the categories such as "18 and below", and 16 years old is

the minimum age reported. On the other hand, the life expectancy of the region (Mainland China, Hong Kong, Macau, Taiwan) at the survey time is chosen as the upper bound. The expected life data is collected from the World Bank Database[9] and Index mundi[10]. Note that the life expectancy data of mainland China in 2012 is not available so the data in 2011 was used instead.

Similar with average educational and age, the average income is calculated from given distribution when it is not available. If the category does not provide upper level or lower level, the lower level is set as 0, while the upper level is set at the 110% or 125% of the highest value given, thus two different mean incomes are calculated. Since the monetary terms were collected in different currency unit over 20 years, the adjustment according to CPI and PPP would be necessary for further analysis. Following the approach described in Jacobsen and Hanley (2008), monetary terms were firstly adjusted to 2010 in the given currency via CPI, and then converted to US Dollar in 2010 with PPP. The indexes of CPI were collected from the National bureau of statistics of China[11] for Chinese Yuan, the Census and Statistics Department of the Government of the Hong Kong Special Administrative Region[12][13] for Hong Kong Dollar, the Government of Macao Special Administrative Region's Statistics and Census Service[14] for Macau Pataca, the Directorate-General of Budget, Accounting and Statistics, Executive Yuan of R.O.C (Taiwan)[15] for New Taiwan Dollar and U.S. Bureau of Labor Statistics[16] for US Dollar. While PPP were accessed from Center for International Comparisons of Production, Income and Prices of University of Pennsylvania[17]

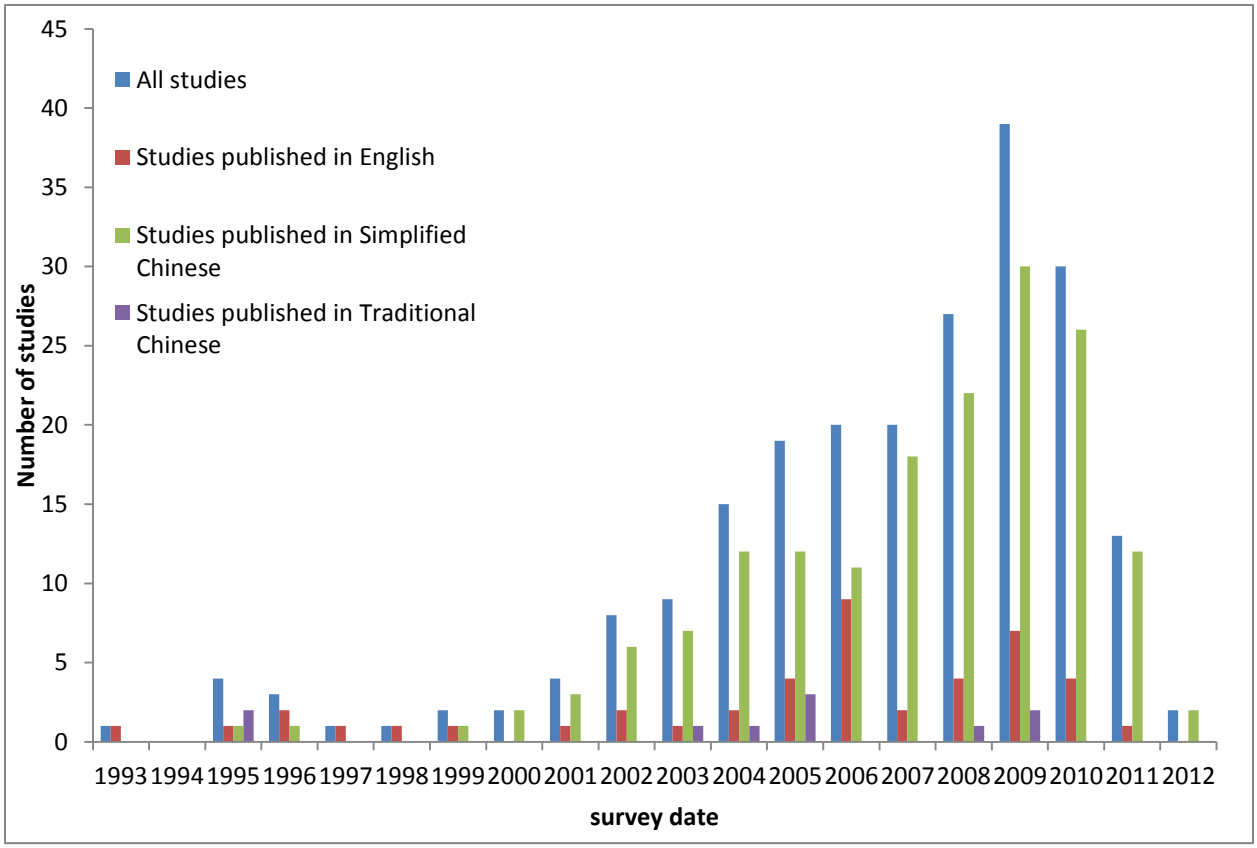
3.3 Description of meta-data

3.3.1 Time distribution

From the established database, some characteristics of existing stated preference studies of Chinese environmental valuation can be revealed. The database contains 269 WTP values from

[9] http://data.worldbank.org/indicator/SP.DYN.LE00.IN
[10] http://www.indexmundi.com/g/g.aspx?c=tw&v=30
[11] http://www.stats.gov.cn/tjsj/ndsj/2012/html/I0901e.htm
[12] http://www.censtatd.gov.hk/press_release/pressReleaseDetail.jsp?charsetID=1&pressRID=3352
[13] http://www.censtatd.gov.hk/hkstat/sub/so60.jsp
[14] http://www.dsec.gov.mo/Statistic.aspx?lang=en-US&NodeGuid=da5597b5-5a7d-4930-85e9-fc00669080e1
[15] http://www.dgbas.gov.tw/ct.asp?xItem=33090&CtNode=2850&mp=1
[16] ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt
[17] Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 7.1, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, July 2012. Link: https://pwt.sas.upenn.edu/php_site/pwt71/pwt71_form.php

220 separate studies published from 1996 to 2013. According to the information reported in studies, the stated preference surveys were conducted during 1993 to 2012. Figure 1 shows the developing trend of such studies based on survey date[18]. It illustrates that before 2000, the application of stated preference researches were really in its childhood, with a few studies implemented steadily over the 7 years period. Also, during this stage the majority of studies are published in English or traditional Chinese, which indicates that this method had not been paid much attention by Chinese domestic scholars. However, after 2000 it represents a significant growth of studies, mainly because of the increase of studies published in Simplified Chinese. As to studies in English, the number of studies with survey time in 2000 and later is 5.3 times of those with survey time before 2000, while the ratio to studies in Simplified Chinese is 54.7 and to studies in Traditional Chinese it is only 4. Thus to include Chinese domestic studies would significantly increase the sample size and diversity for meta-analysis.



[18] "Survey date" refers to the time when the surveys were conducted. Because of the delay between survey implement and article publication, the decreasing trend does not mean less studies of stated preference studies on Chinese ecosystem services in recent period.

Figure 1: Study date of stated preference environmental valuation studies in China

Source: author

3.3.2 Spatial distribution

The spatial distribution of studies is shown in figure 2. Although the total number of studies for analysis is 220, since several studies evaluated environmental assets from different provinces while others may fail to report specific regions, the sum of studies conducted in each province would de different from 220. As to the major Chinese regions[19], most studies were conducted in eastern region (Beijing, Tianjin, Hebei, Shandong, Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan), which has 84 studies conducted. While the Western region (Nei Mongol/Inner Mongolia , Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang) ranks secondly with 73 studies, followed by central region (Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan) (34 studies), Taiwan (16 studies), northeastern region (Liaoning, Jilin, Heilongjiang) (12 studies) and Hong Kong, Macau (both 2 studies). From the spatial distribution, it is shown that developed regions such as Beijing, Shanghai and other eastern, southern or coastal province would have more evaluation studies conducted then most of the central, northeastern and western provinces, for people in developed region would pay more attention to ecosystem services and environmental quality. On the other hand, many studies were conducted in several western regions, such as Gansu and Nei Mongol that ranking 1st and 6th in studies per province, because of local fragile ecosystem or severe pollutions. However, most of other western and central provinces have only limited studies conducted to evaluate local environmental asset. Consider the increasing environmental challenge associated with the economic develop in those regions, current studies may not satisfied the demand of environmental evaluations, thus the benefit transfer method would be a favorable alternative

[19] Source of the division of eastern, central, western, northeastern regions of Mainland China: http://www.stats.gov.cn/ztjc/zthd/sjtjr/dejtjkfr/tjkp/201106/t20110613_71947.htm

option.

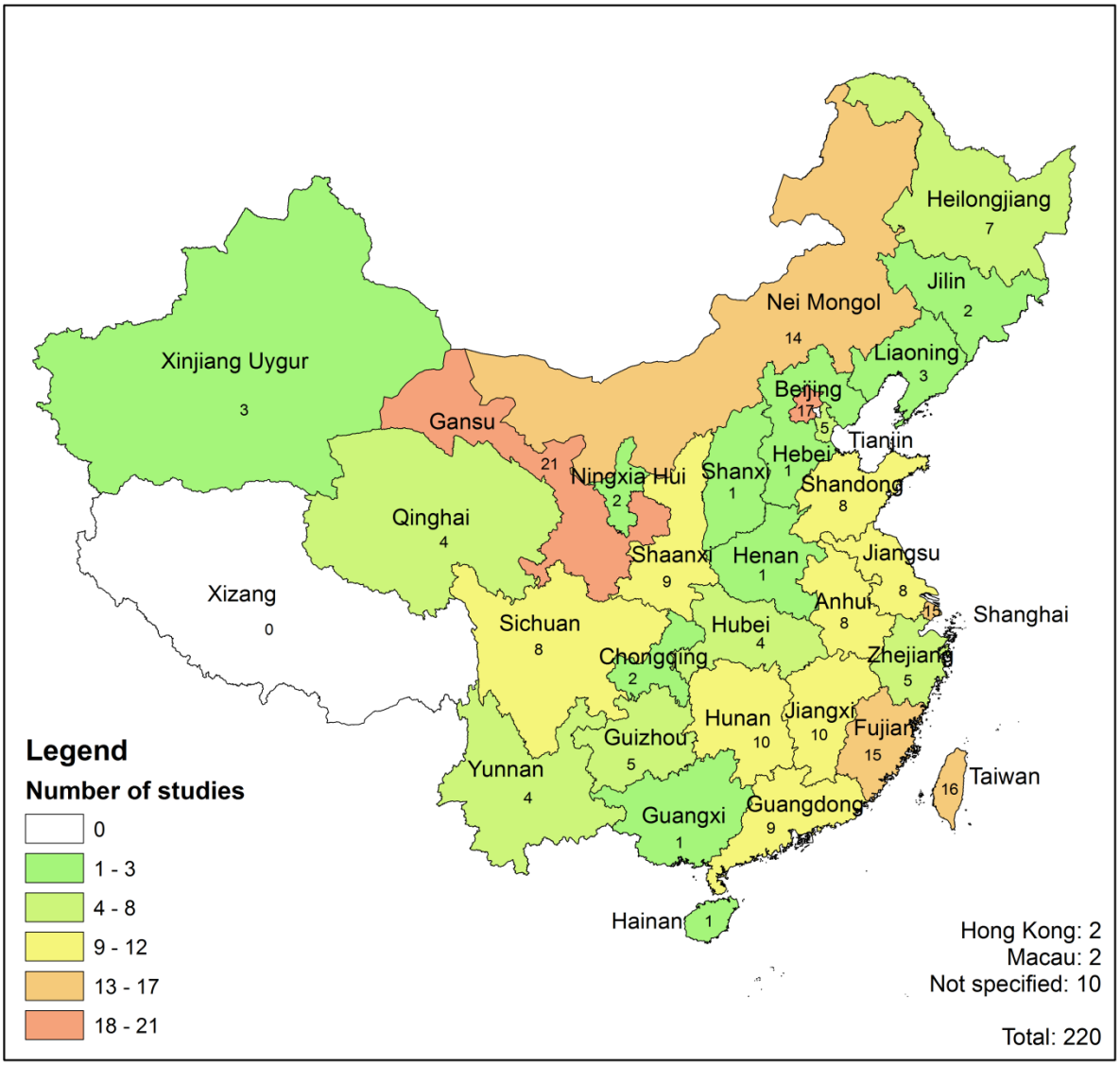


Figure 2: Spatial distribution of stated preference environmental valuation studies in Mainland China, Hong Kong, Macau and Taiwan (1993-2012)

Source: author

3.3.3 Environmental assets distribution

As is shown section 3.2.1, the environmental assets evaluated are divided into ten categories: air quality, animal/plant/biodiversity, bay/marine, ecosystem/environment in general, forest, grassland, lake/reservoir, river, urban green space and wetland. As is shown in figure 3, about

one fourth of studies evaluated the ecosystem or environment as a whole. Among the separate environmental goods, river has been paid much attention by scholars, which is consistent of the spatial distribution that eastern and southern provinces have more studies conducted.

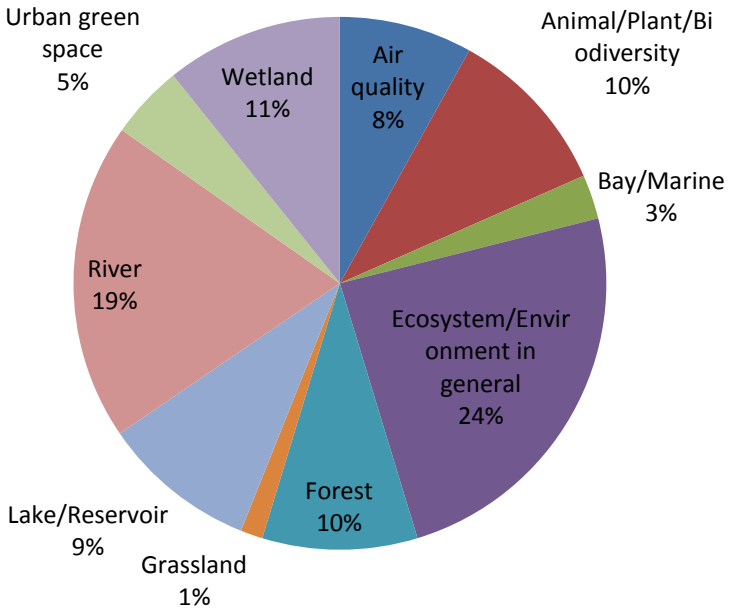


Figure 3: Environmental assets distribution of stated preference studies on environmental valuation in Mainland China, Hong Kong, Macau and Taiwan (1993-2012)

Source: author

By demonstrating the distribution of evaluated environmental goods/services over time and location, we can understand the developing and characteristic of stated preference studies in China. Figure 4 divided the range (1993-2012) of survey time into three period: 1993-2002 (26 studies were conducted), 2003-2007 (83 studies were conducted) and 2008-2012 (111 studies were conducted), it shows that earlier studies tended to evaluated the environment or ecosystem as a whole, and air quality as well as species/biodiversity were popular topics. While in the recent period, the number of evaluations of forest, wetland and river showed strong increasing trends, which demonstrated the shift of stated preference methods' applications.

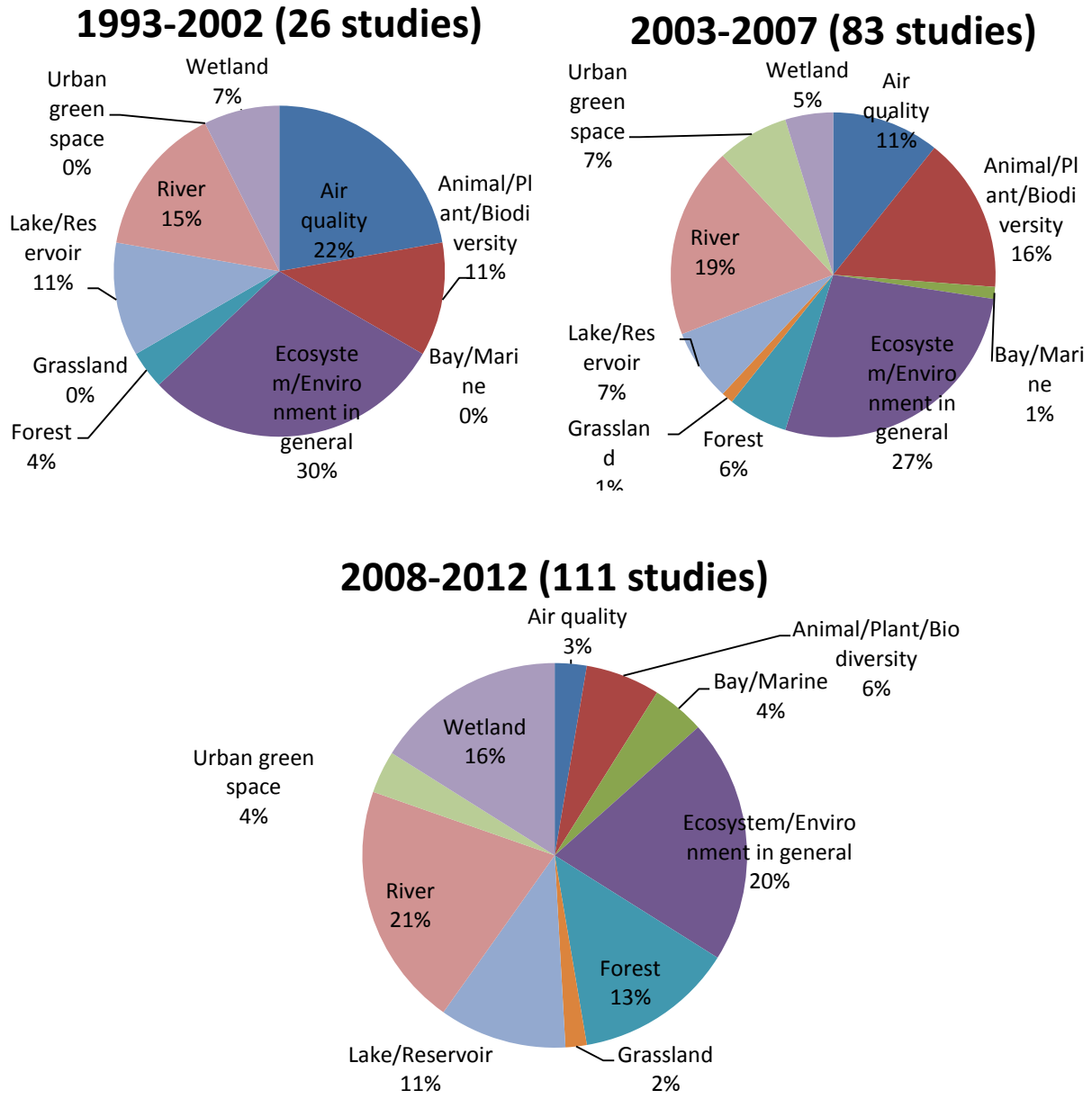


Figure 4: Time distribution of stated preference environmental valuation studies in China[20]

Source: author

Similarly, the evaluated environmental goods/services were distributed according to spatial regions in figure 5. For the convenience of analysis, the region "central" and "northeastern" are combined as one based on the similarity of natural and economic status, same as "Hong Kong",

[20] Note: Since a few studies evaluated multiple environmental goods, the number here is slightly different from that in 3.3.1.

“Macau” and “Taiwan”. As is shown in figure 5, the distribution of environmental goods/services demonstrates the significant regional difference. First of all, the evaluation of “ecosystem/environmental in general” category shows a clear increasing trend from eastern to western region. Secondly, environmental goods such as “river”, “bay/marine” and “grassland” vary with regions greatly, which is consistent with the natural situation. On the other hand, category “wetland” has very steady distribution over the four main regions. Thirdly, according to the distribution, air quality problem in eastern region and species/biodiversity problem in central and northeastern regions has been paid more attention by scholars, comparing with those two topics in other Chinese regions.

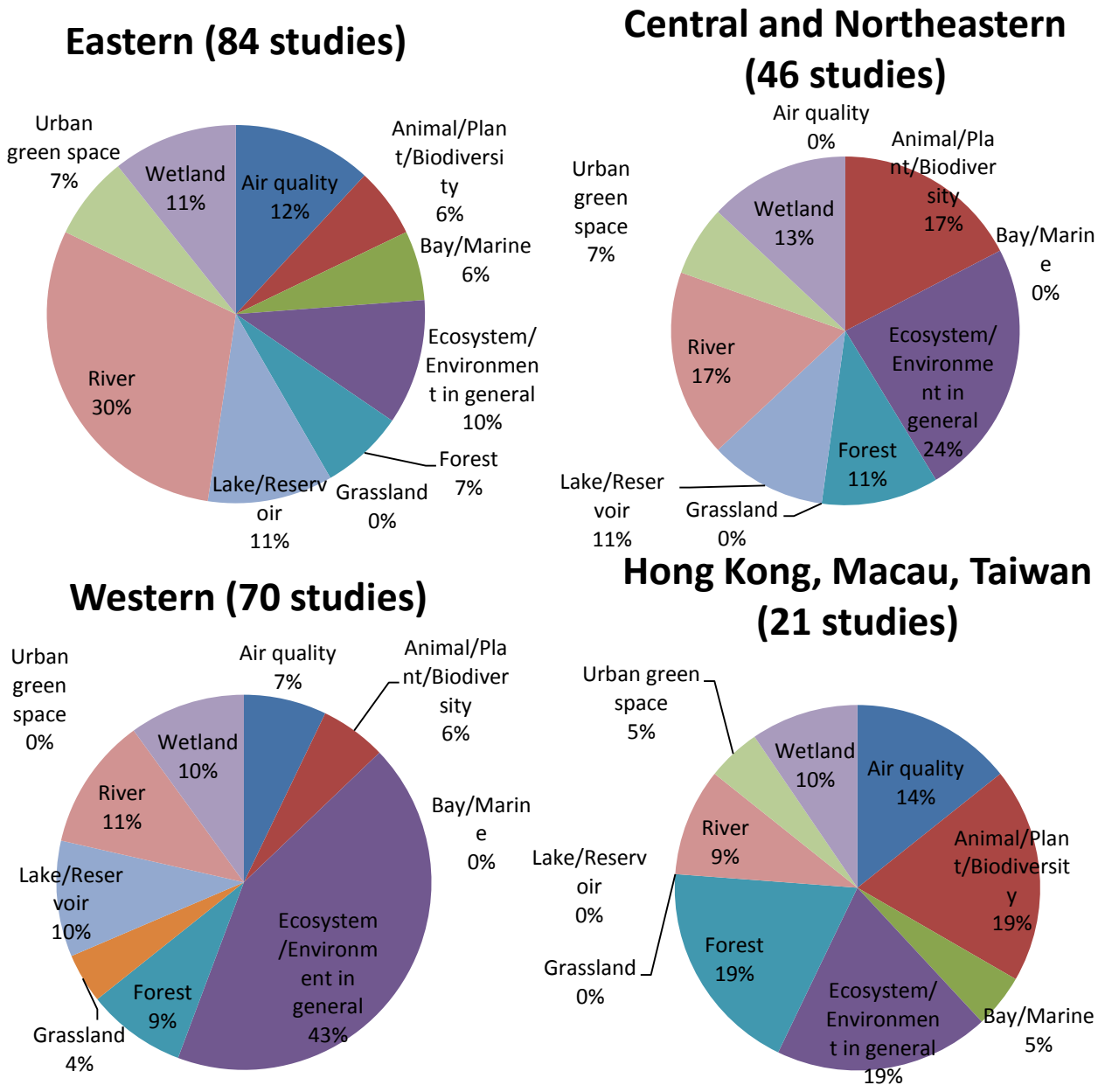


Figure 5: Spatial distribution of stated preference environmental valuation studies in China [21]

Source: author

[21] Note: Since a few studies either failed to provide specific spatial information, evaluated environmental goods across region categories or evaluated multiple environmental goods, the number of studies here is slightly different from that in section 3.3.2.

4. Model

According to the main stream of meta-analytic benefit transfer studies (Rosenberger and Loomis, 2000; Lindhjem and Navrud, 2008; Jacobsen and Hanley, 2009; Brander and Koetse, 2011), the combined benefit function was established as:

$$WTP_i = \beta_0 + \beta_{wtp} W_i + \beta_{methodological} M_i + \beta_{env\ assets} E_i + \beta_{geographic} G_i + \beta_{study\ specific} S_i + \beta_{socio-economic} SE_i + \varepsilon_i$$

Where i refers to the id of value observations, W refers to the WTP related variables, M refers to the methodological variables, E refers to the environmental assets related variables, G refers to the geographic variables, S refers to the study specific variables, SE refers to the socio-economic variables and ε is the observational level error term.

As was found during the studies selection and coding process, researchers reported the WTP observations by the unit both per household and per individual. Also, the majority of WTP observations can be converted into annually term, but there were still several studies reported WTP as one-off payment, per trip payment and few reported WTP per volume and area. Since the unit of WTP varies over observations, a series of WTP related variables were involved in the model, and the double logarithm approach was adopted to transform the numerical variables into their natural logarithm.

Previous studies of meta-analytic benefit transfer also adopted a study level error term with the assumption that observations from same study may have study specific fixed effects, because the number of value observations would exceed the number of studies or surveys greatly, usually by 3 times or higher. For example, Rosenberger and Loomis (2000) established the meta-analysis database of 682 observations from 131 studies, Jacobsen and Hanley (2009) conducted analysis based on 145 observations from 46 studies, and Brander and Koetse (2011) collected 73 value observations from 20 studies, Even if Lindhjem and Navrud (2008) conducted the meta-analysis based on 72 observations from about 50 studies, these studies only contained 26 original surveys. Thus the control of study level impact should be necessary. However, among the 220 separate studies included in the established by author, 173 of them conducted one survey and reported only one observation, 16 studies conducted one survey with multiple evaluations but the

evaluations cannot be distinguished in coded data[22], thus the only the median of those observation was coded, while 31 studies conducted multiple surveys and were all coded, thus these 220 studies only provided 269 separate observations and the observation-to-studies ratio is only about 1.22. The ratio is similar with studies published in Simplified Chinese (200/166 ≈ 1.20) in Traditional Chinese (14/10 = 1.4) and in English (55/44 = 1.25). Based on the situation that the majority of studies only reported one observation, only the observational level error was considered in the model used in this thesis.

Based on the objective of meta-analysis model on examining the influential factors of WTP on ecosystem services, variables in table 2 were selected in each category to research their impacts on the WTP value.

Table 2: Variables for meta-analysis model

Short name	Description
Wtp	WTP (CPI,PPP adjusted to 2010 dollars, dependent variable)
wtp_unitD	Adjusted WTP unit (2010 USD): 0: USD/Not specified, USD/m^3, or USD/hectare, 1: USD/year, 2: USD/one off, 3: USD/trip
wtp_groupD	0:average WTP of all group, 1: average WTP of non-zero group, 2:Not specified
wtp_median	0: mean, 1:median
wtp_houidv	0: WTP per individual, 1: WTP per household
val_ce	Choice sets
val_oe	Open ended question
val_pc	Payment card
val_dc	Dichotomous choice (Reference: Bidding game)
val_donate	Voluntary donation/payment
val_tax	Mandatory tax/payment
val_chosen	Chosen by respondents
val_bill	Utility bill (Reference: Entrance fee)
val_ques	Questionnaire
val_phone	Phone interview
val_mail	Mail or email interview (Reference: In-person interview)
val_intvD	Payment interval. 0: Per Six months, 1: Annually, 2: Monthly, 3: One-off, 4:Per trip
val_loss	Avoid a loss
val_gain	For a gain

[22] For example, one survey asked respondents to provide evaluation on water quality improvement to be "from boatable to fishable", "from fishable to swimmable" and "from swimmable to drinkable", but they would all coded as "improvement" in database for analysis, thus only the evaluation on "from fishable to swimmable" was adopted as WTP values (usually the median), while the other evaluations were mentioned in the database for future reference.

val_cons	Conservation/Maintain current situation (Reference: Payment for ecosystem services)
val_focus	Focused group
val_resid	Resident
val_visitor	Visitor (Reference: General population)
val_rembud	Remind of budget
val_remact	Remind of (not) actual payment
val_scopet	0: not specific. 1: The study discussed on the scope test but did not conduct it. 2: the study conducted scope test.
val_cheapt	0: not specific. 1: The study discussed "cheap talk" script issue but did not adopt it. 2: the study adopted "cheap talk" script.
val_train	Training of interviewers mentioned
val_pre	Pre-testing
ast_airqul	Air quality
ast_biodiv	Animal/Plant/Biodiversity
ast_baymar	Bay/Marine
ast_forest	Forest
ast_grslnd	Grassland
ast_lakres	Lake/Reservoir
ast_river	River
ast_urbgre	Urban green space
ast_wetlan	Wetland (Reference: Ecosystem/Environment in general)
ast_spespe	Specific species
ast_recrea	Recreation value
ast_propakD	0: Not specified, 1: Protected area, 2: Natural park
geoe_c	Central
geoe_e	Eastern
geoe_ne	Northeastern
geoe_h	Hongkong
geoe_m	Macau
geoe_t	Taiwan (Reference: Western)
sur_urban	Urban
sur_samep	Same-province
sur_onasset	On asset
sur_onpub	On public area (Reference: survey in family)
sur_national	National sample
sur_surtimeN1	Survey time-1992 (1 to 20)
doc_typeD	Document category. 0: Conference paper, 1:Journal article, 2: Research report, 3: Master thesis, 4: PhD thesis
pub_langD	Language. 0: In Simplified Chinese, 1: In Traditional Chinese, 2: In English
sur_random	1: Random sample. 0: otherwise
sur_sizeN	Sample size
sur_validrN	Valid response rate

se_inc110N	Mean income (reported and calculated, 110%)[23]
se_houidv	0: Income per individual, 1: Income per household
se_eduyearN	Schooling year
se_ageN	Mean age
se_maleN	Percentage of male respondent

After attempt regression, several updated were made based on the general meta-analysis model. In the socio-economic category the variables of respondents' average education level, average age and the proportion of male respondents were dropped, for the reasons that they were far from significant in all of attempts, and over 50 observations failed to report these variables, thus to add them would decrease the number of observation and loss potential information. So the socio-economic category contains income related variables only. Also, three observations are dropped for the extremely large WTP observations that deviates the mean value over 2 times of standard deviations and are clearly separated from other WTP observations.

Three models were developed as meta-analysis models for regression. (1) The WTP was regressed on the full model that keeps all variables concerned. Since it contains the maximum number of independent variables, the observations were limited because some observations had one or several missing variables. Also, the number of variables is about the half of that of observations. (2) A stepwise trimmed model was developed to regress WTP on WTP related variables and one category (the methodological variables, the environmental assets related variables, the geographic variables, the study specific variables and the socio-economic variables) at each time; only variables significant at $p < 0.2$ levels in each model are kept for WTP regression. Outputs of each step models are shown in appendix 2. (3) A trimmed version of the full model was developed by only keeping variables significant at $p < 0.2$ levels from full model (Lindhjem and Navrud 2008).

[23] The Mean income with 110% assumption of upper boundary was selected instead of that with 125% assumption of upper boundary because of its better performance in attempt regressions.

5. Results and discussion

5.1 Meta-analysis model

The regression results of double log models with robust standard errors are shown in Table 3. Because of the large number of variables in the full model, only those either significant at $p < 0.1$ level or be included in other trimmed model are listed in Table 3.

Table 3: Regression result of meta-regression models

Variables	Model 1:Full model	Model 2: Stepwise trimmed model	Model 3: Trimmed full model
wtp_unitD			
1: USD/year	2.530(1.655)	1.505(1.584)	2.637(1.605)
2: USD/one off	3.491(2.747)	1.518(2.272)	1.389(1.616)
3: USD/trip	2.678(2.028)	1.449(1.560)	2.982*(1.597)
wtp_groupD			
1: average WTP of non-zero group	0.220(0.335)	0.189(0.252)	
2: Not specified	-0.104(0.899)	-0.113(0.435)	
wtp_median	-0.691(0.511)	-0.832**(0.324)	-0.844***(0.285)
wtp_houidv	0.129(0.367)	0.016(0.219)	
val_ce	0.777(1.320)	1.169(1.255)	
val_pc	-0.977*(0.533)		-0.532***(0.147)
val_dc	-0.051(0.582)	0.834***(0.249)	
val_tax	0.040(0.432)	-0.181(0.309)	
val_chosen	0.192(0.236)	-0.001(0.185)	
val_bill	-3.978**(1.560)	-4.118***(1.524)	-2.079**(0.864)
val_ques	-0.760**(0.326)	-0.451**(0.225)	-0.470***(0.153)
val_mail	-1.573*(0.806)	-0.204(0.415)	
val_intvD			
1: Annually	2.058*(1.213)	1.068*(0.615)	1.137***(0.275)
2: Monthly	2.936**(1.259)	1.937***(0.680)	2.204***(0.315)
3: One-off			1.710***(0.289)
val_cons	-0.667(0.487)	-0.365(0.222)	-0.690***(0.137)
val_remact	-1.074(0.647)	-0.693*(0.363)	-0.477(0.306)
val_scopet			
1: discussed	-1.631(1.689)	-0.195(1.458)	

2: conducted	-0.344(1.552)	0.032(0.466)	
val_cheapt			
1: discussed	-0.144(1.072)	-0.128(0.641)	
2: conducted	0.654(1.903)	2.145(1.647)	
val_train	-0.116(0.407)	-0.075(0.260)	
val_pre	0.320(0.255)	0.210(0.229)	
ast_airqul	0.948**(0.377)	0.745**(0.299)	0.360*(0.199)
ast_baymar	2.023**(0.828)	1.152*(0.626)	0.587*(0.354)
ast_grslnd	0.772(0.588)	0.585(0.425)	0.694**(0.292)
ast_lakres	1.268*(0.715)		0.336(0.259)
ast_river	0.348(0.403)	0.287(0.294)	
ast_propakD			
1: Protected area	-0.662(0.564)	-0.121(0.391)	
2: Natural park	0.309(0.969)	-0.249(0.478)	
geoe_c	0.935(0.563)		0.029(0.245)
geoe_e	-0.012(0.295)	-0.183(0.240)	
geoe_h	0.268(1.231)	-0.046(0.510)	
geoe_t	-0.171(1.443)	-0.868(0.664)	
doc_typeD			
2: Research report	-2.775*(1.533)	-0.99**(0.392)	-2.658***(0.399)
3: Master thesis	0.100(0.416)	0.046(0.416)	-0.190(0.165)
4: PhD thesis	0.637(0.788)	0.508(0.561)	0.018(0.328)
pub_langD			
1: In Traditional Chinese	0.122(1.054)	0.268(0.525)	
2: In English	-0.277(0.507)	0.042(0.335)	
lnsur_sizeN	-0.111(0.198)	0.091(0.168)	
lnsur_validrN	-1.228(0.759)		-0.643(0.397)
lnse_inc110N	0.231(0.267)	0.354**(0.17)	
se_houidv	0.249(0.338)	0.065(0.227)	
_cons	-2.223(3.714)	-2.909(2.723)	0.135(1.649)
	(other result omitted)		
Number of observation	136	137	196
Number of variables	68	40	22
F	3.03	4.63	9.56
Prob > F	0	0	0
Adjusted R^2	0.7544	0.6586	0.5487

Note: *** refers to the variable is significant at $p < 0.01$ level, ** refers to the variable is significant at $p < 0.05$ level and * refers to the variable is significant at $p < 0.10$ level. The F value listed here are from model without robust standard errors.

According to table 3, the adjusted R^2 decreased with the increase of observations in that model, but all the three models reported the adjusted R^2 above 0.5 and the F value significant different from zero. As to the specific impact of independent variables on WTP, first of all, to report the median value instead of mean value would lead to a lower WTP estimate. Among the methodology variables, the adopting of dichotomous format increase the WTP while adopting payment card format would decrease it. And setting monthly as the payment interval would result in higher WTP per year comparing with set annually or one-off as the payment vehicle. Another finding from methodology aspect is that to evaluate the maintenance of current ecosystem would lead to the decrease of WTP, while to evaluate the change framework of either for the gain or avoid the loss did not show a significant result. As to the environmental assets, comparing with environment/ecosystem service in general, to evaluating air quality, bay/marine or grassland ecosystem assets would have a significant positive impact on WTP value. All the geographic variables are not significant at even $p < 0.10$ level. Among the study-specific variables, the document type of research reports would have significant lower WTP estimate, but the publication language failed to have significant impact to WTP. Finally, although not significant in the full model and be excluded from the trimmed version of the full model (model 3), the average income of respondents have significant positive impact on WTP according to the step-by-step model, which is consistent with expectation. The findings on WTPs' influential factors may provide suggestions on future stated preference studies' design and implement, as well as for further methodological study on CV method.

5.2 Analysis of benefit transfer error

As the indicator of accuracy of benefit transfer method, the transfer error refers to the proportion of the difference between valuation predicted from benefit transfer method and that from original study, comparing with the original valuation (Lindhjem and Navrud 2008), or:

$$TE = \frac{|WTP_{predicted} - WTP_{original}|}{WTP_{original}}$$

In order to analyze the transfer error, the N-1 test was applied, which can be conducted as follows. Firstly, one study was selected as the virtual "policy site", while the remaining N-1 (N refers to the total number of original studies available) studies were combined to produce the meta-analysis function based according to the benefit transfer model. Secondly, the variables from "policy site" were used to produce the predicted valuation according to the meta-analysis function. Thirdly, the transfer error was calculated according to the function above. By replacing the process by N times, the transfer errors of each study would be available for further analysis (Lindhjem and Navrud 2008).

The results of full model, stepwise trimmed model and trimmed version of the full model were adopted for transfer error test as meta-analytic benefit transfer approaches, together with the central tendency approach. In the N-1 test of central tendency approach, WTP from similar studies were average as the predicted WTP. since the WTP estimates have different unit, here only the unit of "USD/year" were kept for analysis, which made up the majority of all observations (238 out of 266). When one study was selected as the "policy site", the average WTP of all the other studies evaluating the same environmental asset and in the same form (WTP per household or per capita) was generated as the predicted WTP through central tendency approach. Then that the transfer error was calculated based on the predicted WTP and original WTP on "policy site".

The results of transfer errors are shown in table 4 and figure 6. It was found that the trimmed full model had best performance of benefit transfer among all approaches listed here with the distribution closer to zero transfer error, the stepwise trimmed model showed similar transfer error with central tendency approach, while the full model had obviously highest transfer errors.

Table 4: Transfer error of benefit transfer approaches

	Model 1: Full model	Model 2: Stepwise trimmed model	Model 3: Trimmed full model	Central tendency approach
Mean	4.912	1.956	1.393	1.791
Median	0.789	0.66	0.514	0.687

Number of observations	136	137	196	233

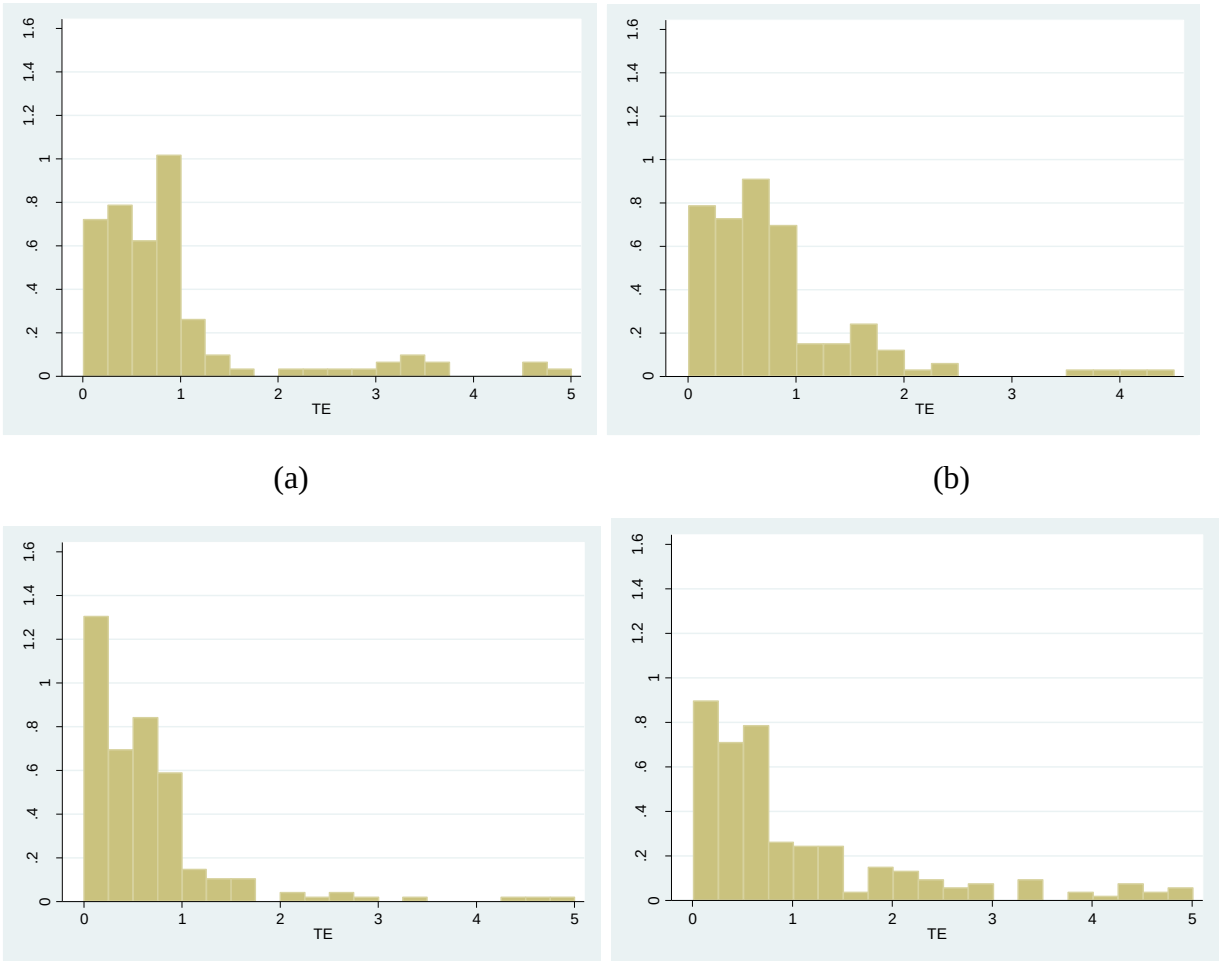


Figure 6. Distribution of transfer errors from benefit transfer approaches

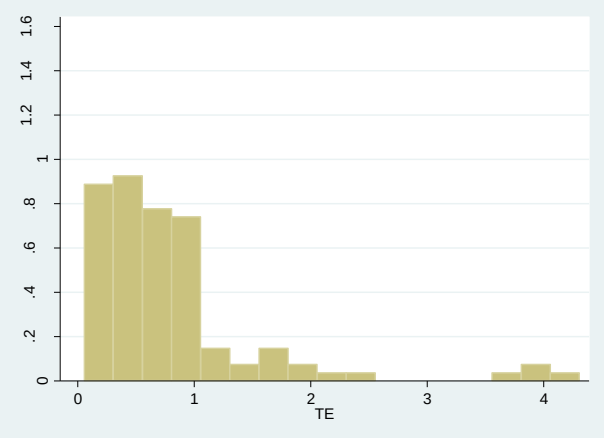
(a): Full model; (b) Stepwise trimmed model; (c): Trimmed full model; (d): Central tendency approach

However, because several observations did not report full information on all variables, when the selection of variables in the model varied, the selected sample of observations would also be different from each other. Thus these four approaches were re-run on the same sample of WTP observations (Lindhjem and Navrud 2008). Although this adjustment further limited the number of observations in all of these approaches, it would provide a fair platform to compare the

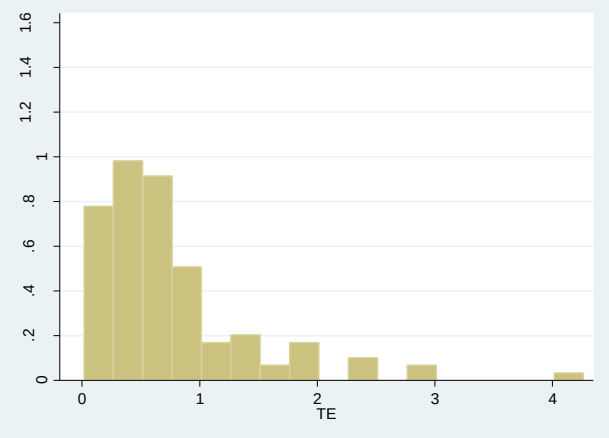
transfer errors and distributions. The results on same observations were provided in table 5 and figure 7.

Table 5: Transfer error of benefit transfer approaches (with same observations)

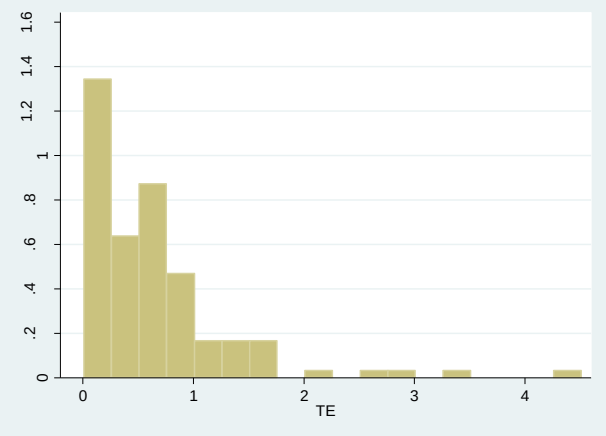
	Model 1: Full model	Model 2: Stepwise trimmed model	Model 3: Trimmed full model	Central tendency approach
Mean	4.963	1.026	0.911	1.723
Median	0.674	0.583	0.543	0.729
Number of observations	122	122	122	122

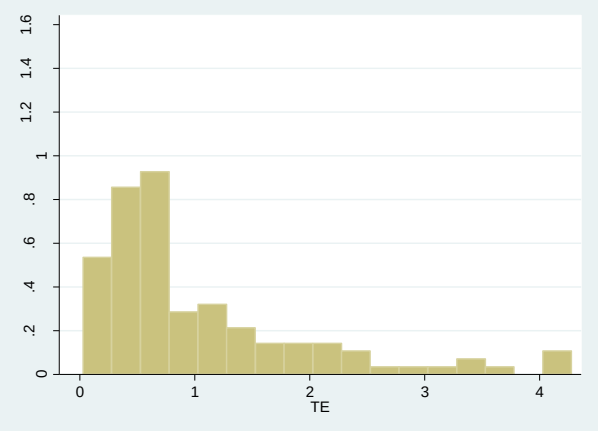


(a)



(b)





(c) (d)

Figure 7. Distribution of transfer errors from benefit transfer approaches

(with same observations)

(a): Full model; (b) Stepwise trimmed model; (c): Trimmed full model; (d): Central tendency approach

When the transfer errors were calculated based on the same observations with smaller size of sample but more information of variables in each observation, the results indicated that among the three meta-analytic approaches, the performances kept the same order that Trimmed full model exceeded the stepwise trimmed model, while the full model had worst performance. However, comparing the results between meta-analytic models and that from central tendency approach, the control of observations increased the quality of two trimmed models obviously but had less impact on central tendency approach, which made it worse than stepwise trimmed models based on meta-analysis. Thus the test with same observations suggested that when more information of independent variables were available, to conduct the meta-analytic benefit transfer following the trimmed approach would result in better transfer results than central tendency approach, which indicated that with a more comprehensive databases of original studies, the trimmed meta-analytic benefit transfer would be more reliable for applications.

5.3 Difference between studies published in English and Chinese

As is shown in section 5.1, the impact of publication language on WTP estimate is not significant in meta-analytic models. However, the publication language may still raise the concerns including research quality, focused asset and popular methodologies, thus the question emerged that whether there were inherent different characteristics between studies published in different languages. The relationship between publication language and other independent variables were tested by a series of T-test with consideration of equal or unequal variance (The studies published both in Simplified and Traditional Chinese are combined as “Chinese”). The sample for language impact test included all the observations, thus there would be 214 observations from 176 studies published in Chinese and 55 observation from 44 studies published in English.

Table 6 shows the results of one-tailed T-test on dummy variables, by the order of difference between studies published in English and in Chinese, variables significant at 0.05 level are marked in bold font.

Table 6: T-test of dummy variables by publication language

Variable	Mean(Eng)	Mean(Chn)	Mean(Eng)-Mean(Chn)	Pr	Ttest method
val_dc	**0.436**	**0.154**	**0.282**	**0.000**	**unequal**
val_pre	**0.764**	**0.514**	**0.250**	**0.000**	**equal**
val_intw	**0.818**	**0.621**	**0.197**	**0.003**	**equal**
val_donate	**0.273**	**0.121**	**0.151**	**0.011**	**unequal**
val_gain	**0.655**	**0.509**	**0.145**	**0.027**	**equal**
val_train	**0.291**	**0.164**	**0.127**	**0.030**	**unequal**
sur_infamily	**0.455**	**0.332**	**0.123**	**0.045**	**equal**
geoe_t	**0.182**	**0.070**	**0.112**	**0.024**	**unequal**
val_loss	**0.164**	**0.061**	**0.103**	**0.028**	**unequal**
ast_urbgre	**0.127**	**0.028**	**0.099**	**0.019**	**unequal**
val_rembud	**0.127**	**0.047**	**0.081**	**0.048**	**unequal**
val_ce	**0.091**	**0.014**	**0.077**	**0.030**	**unequal**
val_bid	**0.073**	**0.000**	**0.073**	**0.022**	**unequal**
ast_spespe	0.127	0.056	0.071	0.071	unequal
ast_biodiv	0.164	0.093	0.070	0.100	unequal
sur_urban	0.727	0.659	0.068	0.168	equal
ast_recrea	0.273	0.210	0.062	0.161	equal
val_tax	0.127	0.065	0.062	0.103	unequal
sur_subn	0.909	0.864	0.045	0.188	equal
ast_lakres	0.127	0.089	0.038	0.195	equal
geoe_h	0.036	0.000	0.036	0.080	unequal
ast_forest	0.127	0.093	0.034	0.229	equal
sur_rural	0.067	0.034	0.033	0.589	equal
val_bill	0.055	0.023	0.031	0.171	unequal
ast_airqul	0.109	0.079	0.030	0.242	equal
val_resid	0.836	0.808	0.028	0.318	equal
val_oe	0.127	0.112	0.015	0.378	equal
geoe_m	0.018	0.005	0.014	0.237	unequal
val_remscope	0.018	0.009	0.009	0.325	unequal
val_ent	0.036	0.033	0.004	0.447	equal
geoe_ne	0.055	0.056	-0.002	0.483	equal
sur_onpub	0.073	0.079	-0.007	0.435	equal

val_genpop	0.000	0.009	-0.009	0.079	unequal
sur_onconf	0.000	0.009	-0.009	0.079	unequal
val_phone	0.018	0.028	-0.010	0.342	equal
ast_grslnd	**0.000**	**0.014**	**-0.014**	**0.042**	**unequal**
sur_onasset	0.218	0.238	-0.020	0.377	equal
val_focus	**0.000**	**0.023**	**-0.023**	**0.013**	**unequal**
ast_baymar	**0.000**	**0.028**	**-0.028**	**0.007**	**unequal**
val_mail	0.018	0.047	-0.029	0.111	unequal
sur_nonlocal	0.164	0.196	-0.033	0.292	equal
geoe_c	0.109	0.150	-0.040	0.222	equal
val_remoth	0.855	0.897	-0.043	0.186	equal
sur_local	0.727	0.771	-0.044	0.249	equal
val_remact	**0.018**	**0.065**	**-0.047**	**0.030**	**unequal**
sur_national	**0.018**	**0.075**	**-0.057**	**0.014**	**unequal**
val_pes	**0.036**	**0.093**	**-0.057**	**0.040**	**unequal**
ast_wetlan	0.055	0.112	-0.058	0.065	unequal
geoe_w	0.255	0.318	-0.063	0.183	equal
geoe_e	0.327	0.393	-0.065	0.188	equal
sur_samep	0.764	0.832	-0.068	0.122	equal
val_visitor	0.164	0.234	-0.070	0.132	equal
ast_ecoenv	0.200	0.271	-0.071	0.142	equal
val_chosen	0.145	0.220	-0.074	0.113	equal
ast_river	**0.091**	**0.206**	**-0.115**	**0.009**	**unequal**
val_ques	**0.109**	**0.257**	**-0.148**	**0.003**	**unequal**
val_cons	**0.127**	**0.280**	**-0.153**	**0.003**	**unequal**
val_pc	**0.218**	**0.593**	**-0.375**	**0.000**	**equal**

Although the WTP itself is not significantly different between studies published in English or Chinese (p=0.1662, unequal), studies published in different languages do differ on some variables, especially on the methodological variables. Studies published in English were more likely to adopt choice experiment method or dichotomous choice method, use voluntary donation as payment vehicle, conduct face to face interview, report the training of interviewers or pre-test implement, evaluate the payment for avoiding loss or for the gain, remind budget restraint during survey, evaluate urban green space, conduct survey in household. On the other hand, studies published in Chinese tended to use payment card method, distribute and collect questionnaires, evaluate the payment for ecosystem service, or maintain the current environmental quality/ecosystem service, remind of (not) actual payment, during survey,

evaluate bay or marine ecosystem, grassland, and river and select national respondents. Although the publication language did not have significant impact on WTP, the different between studies published domestically and internationally may be of interest by future researches.

6. Conclusion

In this thesis, a database of existing stated preference studies on Chinese ecosystem services and environmental quality evaluation was established by the author to provide the information of such studies in China and for future analysis. It indicated that the number of stated preference studies in China had increased in recent decades, especially because of the domestic Chinese studies. However, it still had unevenly spatial distribution across the country as well as focus on different environmental assets across time periods and regions.

Then the influential factors of WTP for environmental assets were explored via meta-analysis. It was found that variables including response format, research format, payment interval, payment vehicle, document type, and specific environmental assets such as air quality and bay or marine would have significant impacts on WTP estimates. Such results may benefit the design, implement and explanation of further researches on Chinese ecosystem services.

Finally, the feasibility of conducting benefit transfer in China was tested in the measurement of transfer error, and the accuracy of meta-analytic approaches was compared with central tendency approach. The trimmed version of the full model had best performance on transfer accuracy, followed by stepwise trimmed model, central tendency approach and full model. When control the sample of observations to be the same across different approaches, the performance of trimmed models was improved because of the observation with more variables available was used for benefit transfer. Thus the meta-analytic approach was suggested for further application in China, especially with more comprehensive databases.

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Appendix

Appendix 1: Output of full model

	Coefficient	Std.Err	t	P>|t|
wtp_unitD				
1: USD/year	2.530	1.655	1.530	0.131
2: USD/one off	3.491	2.747	1.270	0.208
3: USD/trip	2.678	2.028	1.320	0.191
wtp_groupD				
1: average WTP of non-zero group	0.220	0.335	0.650	0.515
2: Not specified	-0.104	0.899	-0.120	0.909
wtp_median	-0.691	0.511	-1.350	0.181
wtp_houidv	0.129	0.367	0.350	0.726
val_ce	0.777	1.320	0.590	0.558
val_oe	-0.804	0.654	-1.230	0.223
val_pc	-0.977	0.533	-1.830	0.071
val_dc	-0.051	0.582	-0.090	0.931
val_donate	-0.068	0.527	-0.130	0.898
val_tax	0.040	0.432	0.090	0.926
val_chosen	0.192	0.236	0.820	0.418
val_bill	-3.978	1.560	-2.550	0.013
val_ques	-0.760	0.326	-2.330	0.023
val_phone	-0.169	0.696	-0.240	0.808
val_mail	-1.573	0.806	-1.950	0.055
val_intvD				
1: Annually	2.058	1.213	1.700	0.094
2: Monthly	2.936	1.259	2.330	0.023
val_loss	-0.390	0.645	-0.600	0.547
val_gain	-0.066	0.410	-0.160	0.873
val_cons	-0.667	0.487	-1.370	0.175
val_focus	-0.791	1.392	-0.570	0.572
val_resid	0.041	0.911	0.050	0.964
val_visitor	-0.172	0.767	-0.220	0.823
val_rembud	0.457	0.680	0.670	0.504
val_remact	-1.074	0.647	-1.660	0.102
val_scopet				
1: discussed	-1.631	1.689	-0.970	0.338
2: conducted	-0.344	1.552	-0.220	0.825
val_cheapt				
1: discussed	-0.144	1.072	-0.130	0.894

2: conducted	0.654	1.903	0.340	0.732
val_train	-0.116	0.407	-0.290	0.776
val_pre	0.320	0.255	1.260	0.214
ast_airqul	0.948	0.377	2.520	0.014
ast_biodiv	-0.210	0.581	-0.360	0.719
ast_baymar	2.023	0.828	2.440	0.017
ast_forest	0.167	0.581	0.290	0.774
ast_grslnd	0.772	0.588	1.310	0.194
ast_lakres	1.268	0.715	1.770	0.081
ast_river	0.348	0.403	0.860	0.391
ast_urbgre	0.508	1.021	0.500	0.621
ast_wetlan	0.621	0.487	1.280	0.207
ast_spespe	1.166	0.991	1.180	0.243
ast_recrea	0.131	0.504	0.260	0.796
ast_propakD				
1: Protected area	-0.662	0.564	-1.170	0.245
2: Natural park	0.309	0.969	0.320	0.751
geoe_c	0.935	0.563	1.660	0.101
geoe_e	-0.012	0.295	-0.040	0.967
geo_ne	0.076	0.544	0.140	0.889
geoe_h	0.268	1.231	0.220	0.828
geoe_t	-0.171	1.443	-0.120	0.906
sur_urban	-0.074	0.369	-0.200	0.841
sur_samep	-0.001	0.403	0.000	0.998
sur_onasset	0.062	1.045	0.060	0.953
sur_onpub	0.031	0.702	0.040	0.965
sur_national	0.141	0.550	0.260	0.799
lnsur_surtimeN1	0.019	0.534	0.040	0.972
doc_typeD				
2: Research report	-2.775	1.533	-1.810	0.075
3: Master thesis	0.100	0.416	0.240	0.811
4: PhD thesis	0.637	0.788	0.810	0.422
pub_langD				
1: In Traditional Chinese	0.122	1.054	0.120	0.908
2: In English	-0.277	0.507	-0.550	0.586
sur_random	-0.163	0.331	-0.490	0.623
lnsur_sizeN	-0.111	0.198	-0.560	0.577
lnsur_validrN	-1.228	0.759	-1.620	0.110
lnse_inc110N	0.231	0.267	0.860	0.391
se_houidv	0.249	0.338	0.740	0.464
_cons	-2.223	3.714	-0.600	0.552

Number of observation	136
Number of variables	68
F	3.03
Prob > F	0
Adjusted R^2	0.7544

Note: The F value listed here are from model without robust standard errors.

Appendix 2: Output of stepwise models

Regress WTP on WTP related variables only:

	Coefficient	Std.Err	t	P>|t|
wtp_unitD				
1: USD/year	0.954	0.796	1.200	0.232
2: USD/one off	0.283	0.841	0.340	0.736
3: USD/trip	1.043	0.838	1.240	0.214
wtp_groupD				
1: average WTP of non-zero group	0.110	0.293	0.380	0.708
2: Not specified	-0.811	0.452	-1.790	0.074
wtp_median	-0.801	0.314	-2.550	0.011
wtp_houidv	0.410	0.155	2.640	0.009
_cons	2.439	0.770	3.170	0.002
Number of observation	260			
Number of variables	7			
F	5.05			
Prob > F	0			
Adjusted R^2	0.102			

Regress WTP on WTP related variables and methodological variables only:

	Coefficient	Std.Err	t	P>|t|
wtp_unitD				
1: USD/year	1.865	1.451	1.280	0.200
2: USD/one off	0.559	1.536	0.360	0.716
3: USD/trip	2.900	1.794	1.620	0.108
wtp_groupD				
1: average WTP of non-zero group	0.122	0.295	0.410	0.680

2: Not specified	0.429	0.400	1.070	0.285
wtp_median	-1.009	0.331	-3.040	0.003
wtp_houidv	0.032	0.177	0.180	0.857
val_ce	0.987	0.574	1.720	0.087
val_oe	-0.190	0.271	-0.700	0.483
val_pc	-0.304	0.243	-1.250	0.212
val_dc	0.387	0.292	1.330	0.186
val_donate	0.236	0.227	1.040	0.299
val_tax	-0.541	0.290	-1.870	0.064
val_chosen	0.296	0.151	1.960	0.052
val_bill	-2.426	0.751	-3.230	0.001
val_ques	-0.324	0.164	-1.970	0.050
val_phone	0.399	0.529	0.750	0.452
val_mail	0.144	0.333	0.430	0.667
val_intvD				
1: Annually	1.236	0.564	2.190	0.030
2: Monthly	2.217	0.564	3.930	0.000
3: One-off	1.265	0.605	2.090	0.038
val_loss	-0.252	0.323	-0.780	0.437
val_gain	0.152	0.197	0.770	0.440
val_cons	-0.716	0.185	-3.880	0.000
val_focus	0.606	0.498	1.220	0.226
val_resid	0.155	0.295	0.530	0.599
val_visitor	0.157	0.258	0.610	0.543
val_rembud	0.185	0.436	0.420	0.671
val_remact	-0.678	0.309	-2.200	0.029
val_scopet				
1: discussed	0.507	0.426	1.190	0.235
2: conducted	0.548	0.373	1.470	0.143
val_cheapt				
1: discussed	0.622	0.701	0.890	0.375
2: conducted	0.888	0.659	1.350	0.179
val_train	-0.446	0.181	-2.470	0.015
val_pre	0.232	0.156	1.490	0.139
_cons	0.317	1.770	0.180	0.858

Number of observation	230
Number of variables	35
F	5.63
Prob > F	0

Adjusted R^2	0.504

Note: The F value listed here are from model without robust standard errors.

Regress WTP on WTP related variables and environmental asset variables only:

	Coefficient	Std.Err	t	P>|t|
wtp_unitD				
1: USD/year	1.109	0.843	1.320	0.189
2: USD/one off	0.446	0.933	0.480	0.633
3: USD/trip	1.190	0.898	1.330	0.186
wtp_groupD				
1: average WTP of non-zero group	0.023	0.300	0.080	0.940
2: Not specified	-0.714	0.496	-1.440	0.152
wtp_median	-0.805	0.298	-2.700	0.007
wtp_houidv	0.280	0.169	1.660	0.099
ast_airqul	0.974	0.278	3.510	0.001
ast_biodiv	0.353	0.308	1.150	0.253
ast_baymar	0.740	0.474	1.560	0.120
ast_forest	0.153	0.315	0.490	0.627
ast_grslnd	0.605	0.329	1.840	0.067
ast_lakres	-0.014	0.340	-0.040	0.967
ast_river	0.631	0.236	2.670	0.008
ast_urbgre	-0.382	0.359	-1.060	0.289
ast_wetlan	0.154	0.227	0.680	0.497
ast_spespe	-0.024	0.387	-0.060	0.950
ast_recrea	-0.033	0.197	-0.170	0.866
ast_propakD				
1: Protected area	-0.342	0.206	-1.660	0.098
2: Natural park	0.864	0.396	2.180	0.030
_cons	2.092	0.770	2.720	0.007
Number of observation	260			
Number of variables	20			
F	4.19			
Prob > F	0			
Adjusted R^2	0.202			

Regress WTP on WTP related variables and geographic variables only:

	Coefficient	Std.Err	t	P>|t|

wtp_unitD				
1: USD/year	1.059	0.797	1.330	0.185
2: USD/one off	0.451	0.863	0.520	0.602
3: USD/trip	1.113	0.819	1.360	0.176
wtp_groupD				
1: average WTP of non-zero group	0.130	0.285	0.450	0.650
2: Not specified	-0.782	0.555	-1.410	0.160
wtp_median	-0.841	0.291	-2.890	0.004
wtp_houidv	0.440	0.163	2.710	0.007
geoe_c	0.187	0.231	0.810	0.420
geoe_e	0.477	0.202	2.360	0.019
geo_ne	-0.151	0.217	-0.700	0.486
geoe_h	1.152	0.399	2.890	0.004
geoe_m	1.086	0.666	1.630	0.105
geoe_t	0.954	0.299	3.190	0.002
sur_urban	-0.118	0.188	-0.630	0.529
sur_samep	-0.157	0.172	-0.910	0.362
_cons	2.243	0.748	3.000	0.003
Number of observation	260			
Number of variables	15			
F	4.32			
Prob > F	0			
Adjusted R^2	0.164			

Regress WTP on WTP related variables and study specific variables only:

	Coefficient	Std.Err	t	P>|t|
wtp_unitD				
1: USD/year	1.547	1.048	1.480	0.141
2: USD/one off	0.424	1.137	0.370	0.709
3: USD/trip	1.049	1.037	1.010	0.313
wtp_groupD				
1: average WTP of non-zero group	0.152	0.283	0.540	0.592
2: Not specified	-0.459	0.299	-1.530	0.127
wtp_median	-0.842	0.310	-2.720	0.007
wtp_houidv	0.238	0.185	1.290	0.200
sur_onasset	-0.154	0.199	-0.770	0.440

sur_onpub	0.081	0.262	0.310	0.758
sur_national	-0.240	0.297	-0.810	0.421
lnsur_surtimeN1	0.097	0.192	0.500	0.615
doc_typeD				
1: Journal article	1.781	0.338	5.270	0.000
2: Research report	0.079	0.405	0.200	0.845
3: Master thesis	1.583	0.420	3.770	0.000
4: PhD thesis	2.143	0.507	4.230	0.000
pub_langD				
1: In Traditional Chinese	1.003	0.431	2.330	0.021
2: In English	0.350	0.265	1.320	0.188
sur_random	-0.104	0.174	-0.600	0.550
lnsur_sizeN	0.222	0.133	1.680	0.095
lnsur_validrN	0.069	0.403	0.170	0.864
_cons	-1.385	1.165	-1.190	0.236
Number of observation	221			
Number of variables	20			
F	2.43			
Prob > F	0.001			
Adjusted R^2	0.196			

Note: The F value listed here are from model without robust standard errors.

Regress WTP on WTP related variables and socio-economic variables only:

	Coefficient	Std.Err	t	P>|t|
wtp_unitD				
1: USD/year	1.92246	1.26532	1.52	0.131
2: USD/one off	1.4004	1.29048	1.09	0.28
3: USD/trip	0.846	1.29108	0.66	0.513
wtp_groupD				
1: average WTP of non-zero group	0.14356	0.26536	0.54	0.589
2: Not specified	-0.5648	0.49233	-1.15	0.253
wtp_median	-0.7803	0.34562	-2.26	0.025
wtp_houidv	0.03868	0.23815	0.16	0.871
lnse_inc110N	0.46845	0.09559	4.9	0
se_houidv	0.405	0.22108	1.83	0.069
Number of observation	164			
Number of variables	9			

F	7.47
Prob > F	0
Adjusted R^2	0.261